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New York (N.Y.) Dept. of Water Supply, Gas...

The water supply system. 1916.

[New York]

[1916]

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INTENTIONAL SECOND EXPOSURES DUE TO PHOTOGRAPHS AND ILLUSTRATIONS

CITY OF NEW YORK

Department of
Water Supply, Gas and Electricity

THE WATER SUPPLY SYSTEM

1916

CITY OF NEW YORK

Department of
Water Supply, Gas and Electricity

THE WATER SUPPLY SYSTEM

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THE WATER SUPPLY SYSTEM
OF
THE CITY OF NEW YORK

The care, operation and development of that portion of this system which is conducted by the municipality are committed by statute to the Department of Water Supply, Gas and Electricity. Its jurisdiction extends to the following among other specific matters:

The sources of supply, collection, pumping and distribution of all water supplied by the municipality (constituting about 92 per cent. of the water used within the City of New York).

The quality of all water, whether supplied by the municipality or by private water companies.

The high-pressure fire service in Manhattan, Brooklyn and at Coney Island.

The collection of water revenue (amounting to about $13,000,000 per annum).

The inspection of water-meters and their installation in places where water is furnished for business consumption.

The regulation of the rates charged by private water companies.

No reference is made to other departmental duties not relevant here.

At the head of the Department is a Commissioner appointed by the Mayor. The present Commissioner is William Williams. The Deputy Commissioner is Delos F. Wilcox.

The Department is divided into four bureaus, the largest of which is the Bureau of Water Supply. At its head is Chief Engineer Merritt H. Smith. The Deputy Chief Engineer is William W. Brush. This Bureau, to which are assigned 2,000 employees more or less, is responsible to the Commissioner for the correct execution of all the departmental duties mentioned in relation to water-supply matters except the collection of the water revenue, the inspection and installation of water-meters and the regulation of the rates charged by private water companies. The collection of the water revenue and the work incidental to the inspection and installation of water-meters are under the Bureau of Water Register, with General Nelson H. Henry in charge.

The construction of the Catskill system is under an entirely separate City organization designated as the Board of Water Supply. When constructed its operation will become an additional duty of the Department of Water Supply, Gas and Electricity.

The present City of New York is the result of a consolidation, in 1898, of two great cities and various adjacent communities. As the water-supplies for these former cities and communities were developed without regard to the present City limits the description of these supplies can best be treated on borough lines, that is, by considering each of the five boroughs of which the City is comprised, separately.

1. BOROUGH OF MANHATTAN

(*a*) *Water-Supplies.*—The Borough of Manhattan, which was originally the City of New York prior to consolidation, was the earliest to be settled, and had no general water-supply system up to 1842, although its population at that time amounted to over 300,000. Prior to that date the citizens were supplied mainly from wells and cisterns

within the City, but the quality and quantity of the supply was unsatisfactory. Numerous schemes were suggested at various times to obtain not only a suitable, but a general supply for the community, among which was that of the Manhattan Water Company, now the Manhattan Bank. This company, in 1800, distributed through a piping system of hollow logs a small quantity of water drawn from wells located at Reade and Centre streets, but this supply did not meet the demand. The Croton river was next considered, and it was decided to build an aqueduct from there to the City. In 1842 the aqueduct, with two storage reservoirs, was opened, and is used to this day. The aqueduct supplied a quality and quantity of water to satisfy the demands of the

NEW CROTON DAM

inhabitants up to about 1880, when a shortage was keenly felt, due to its inadequate capacity. To relieve this deficiency a Commission was formed to build a new aqueduct and also such additional storage reservoirs in the watershed as required. The new aqueduct was under construction from 1885 to 1893, and the last reservoir undertaken by the Commission was Croton Falls, which was finished in 1911.

Previous to 1911 additional reservoirs were constructed from time to time to meet the demands of Manhattan borough, due to its growth, so that at present there are ten reservoirs and six lakes in the Croton watershed storing 104,000 million gallons. The reason for this large storage is due to the fact that the flow of Croton river, the main source of this borough's supply, varies greatly in volume, falling in times of severe drought to practically nothing, the evaporation from existing water surfaces being at times greater than the total flow of the river. The Croton river will yield a supply of 336 million gallons daily, assuming that the minimum flow during any series of years will not fall below that previously recorded and that all stored waters are drawn from the reservoirs during such drought period. The total storage is equivalent to

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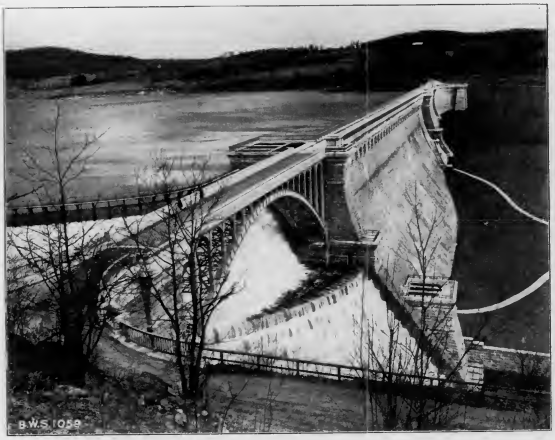

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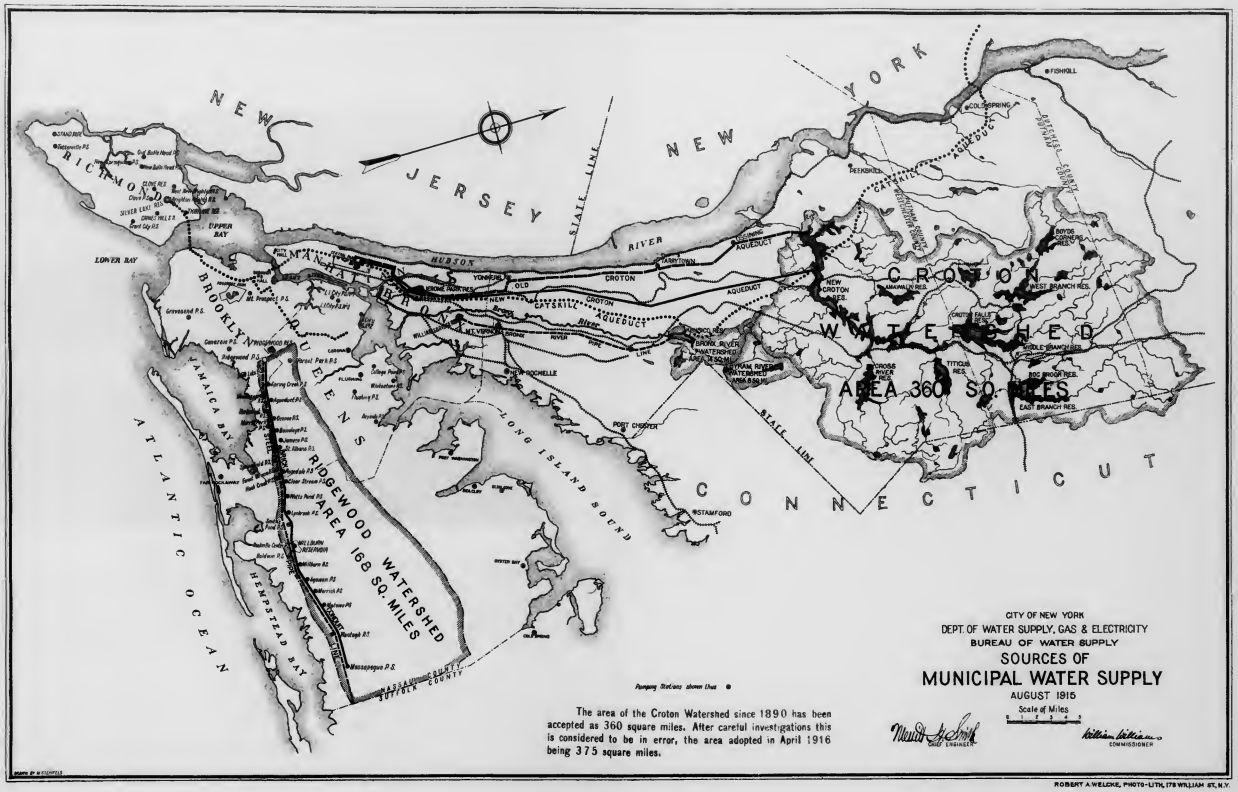

CITY OF NEW YORK
DEPT. OF WATER SUPPLY, GAS & ELECTRICITY
BUREAU OF WATER SUPPLY

SOURCES OF MUNICIPAL WATER SUPPLY

AUGUST 1915

Scale of Miles

The area of the Croton Watershed since 1890 has been accepted as 360 square miles. After careful investigations this is considered to be in error, the area adopted in April 1916 being 375 square miles.

Merritt H. Smith, Chief Engineer
William Wilcox, Commissioner

ROBERT A. WELCKE, PHOTO-LITH, 178 WILLIAM ST, N.Y.

10 months' supply. The reservoirs are useful not only in increasing the available yield of the watershed, but also in furnishing a means of purification of the supply through a long period of sedimentation. The main reservoir is Croton lake, which is formed by the New Croton dam, the spillway being at Elevation 199.06, and the overflow with flash boards on, being two feet higher. This large masonry dam, which was constructed between the years 1892 and 1905 at a cost of approximately $17,000,000 including land, forms a lake 20 miles long which submerges the Old Croton dam and which has a water-level of 170 feet above that of the old stream. The dam is built across the valley of the Croton river three miles up from where it enters the east

CROTON FALLS DAM AND RESERVOIR

CROTON FALLS DAM AND RESERVOIR—It is considered that the economic development of the Croton Watershed supply was reached with the construction of the Croton Falls reservoir. This reservoir, which was started in 1906 and completed in 1911, holds about 15,600 million gallons and increased the probable safe yield of the watershed by approximately 8 million gallons daily. The reservoir is next in size to the Croton Lake reservoir and furnishes one-seventh of the entire storage on the watershed. Its construction added less than one-fortieth to the prior safe supply available from the Croton watershed. The main reservoir is on the west branch of the Croton river, the dam being located about one mile north of the Village of Croton Falls. The storage on the west branch of the Croton river is, with this reservoir, very much greater per square mile of watershed than it is on the east branch.

bank of the Hudson river, above the City of Ossining. The distance that this dam is from the northerly City limits is some 22 miles. The water-level in the aqueducts is about 50 feet lower than the level of the lake when full. Nearly one-third of the total storage capacity in the watershed is in this lake. The other reservoirs and ponds are utilized to maintain the required volume of water in Croton lake. The water drawn from these reservoirs flows through the natural watercourses to the next lower reservoir, eventually reaching Croton lake. The area of the Croton watershed as it exists to-day is 375 square miles, containing a population of about 25,000 mainly concentrated in several small towns and villages.

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(*b*) *Quality of Water.*—The quality of the Croton water is excellent for an unfiltered surface supply and is in a good sanitary condition. The typhoid death-rate, which is generally taken as an index of the quality of the water-supply, as well as the general sanitary condition of the community, was for Manhattan in 1915, 5.3 per 100,000. This rate is much lower than that of other large American cities, and compares very favorably with that of European cities. Nor does the Department concede that any of this small number of deaths from typhoid is attributable to the water-supply. This remark applies also to the deaths from typhoid in the other boroughs.

CROTON FALLS DIVERTING DAM AND RESERVOIR

DIVERTING DAM AND RESERVOIR—A diverting dam was constructed on the east branch about two miles south of the Village of Brewster and northeast of the main dam. This dam raises the water to the same level as the main dam and an open channel a little over one-half mile in length diverts the water of the east branch into the main reservoir.

To conserve the purity of the supply various means are employed, the most important of which are the sanitary patrolling of the watershed, sedimentation, chlorination, analytical examinations and local treatment by the use of copper sulphate. The watershed is divided into 22 sanitary patrol districts, with an employee for each district who is held responsible for the sanitary conditions within his district. Each patrolman is required to daily follow the prescribed route, which averages about 11 miles per day, and to make a written report of his investigations. The average interval of time required to cover a patrol district is about six days.

As previously stated, the large storage capacity affords a sedimentation period which very materially reduces the turbidity of the water before it reaches the consumer. This turbidity is due to the heavy rains, especially those occurring with winter thaws and during the early spring, carrying some of the finer top-soil and clay into

the reservoirs and tributary streams. In spite, however, of great care, water collected on the surface of the ground may become contaminated and dangerous to health. The Department, therefore, now sterilizes all water by treatment with chlorine, which destroys the bacteria. The most important point of chlorine application is at the Dunwoodie plant, located at a point where the Old and New aqueducts closely parallel one another, thus permitting treatment of the flows in both aqueducts at the same time. Besides this plant there are six other plants used for treatment of the waters at points where pollution might occur. This sterilization is supplemented by chemical, bacteriological and microscopical analyses of the waters from various sources, taken either daily, weekly, biweekly or monthly, according to conditions. These samples are

CHLORINATING PLANT, DUNWOODIE, NEW YORK

DUNWOODIE CHLORINATING PLANT—The surface-waters, forming a part of the New York City supply, are now treated with chlorine. The most important plant is that located at Dunwoodie at a point where the Old and New Croton aqueducts closely parallel one another, thus permitting treatment of the flows in both aqueducts from one station. The concrete building illustrated above was put into use in 1912 and represents a modern hypochlorite chlorinating plant. It contains concrete solution and dosing tanks which during 1915 were used in applying an average of nearly 3,500 pounds of hypochlorite daily. This is equivalent by weight of 0.44 part of chlorine per million parts of water treated. The cost of the treatment, including all labor and incidentals, averaged $0.18T per million gallons.

This building is now being altered with a view to installing a liquid chlorine plant, this treatment to replace that by hypochlorite of lime, as it is more effective and economical. This new method of treating the supply will be in operation in the spring of 1916. The old plant will not be disturbed, so that in case of emergency, the supply can be treated by the former method.

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The local treatment with copper sulphate is used for the microscopic growths

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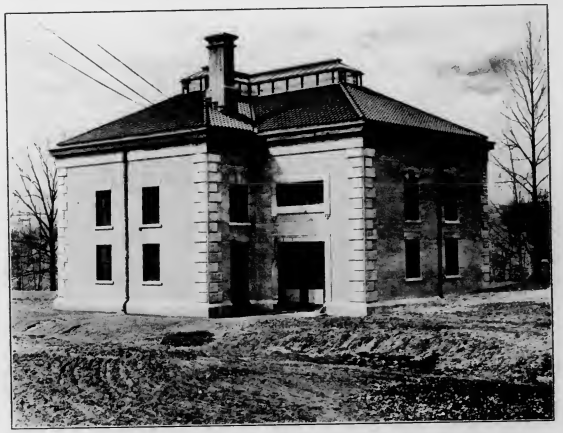

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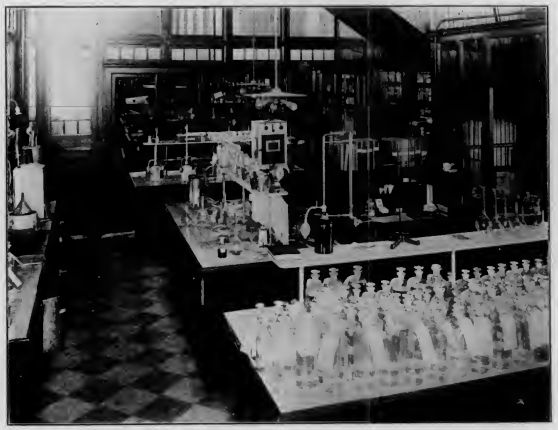
which develop both in the supply and distribution reservoirs, the number being at times sufficient to impart a decided taste and odor to the water. This usually occurs in the latter part of the summer and fall. The growths in the supply reservoirs can readily be controlled by treatment with copper sulphate, but the growths occurring in Central Park reservoirs cannot be controlled, due to the lack of means of temporarily shutting off the reservoir during the two or three days which would be required for treatment. While the taste and odor may be very disagreeable, these organisms have, as far as known, no detrimental effect on the health of the consumer.

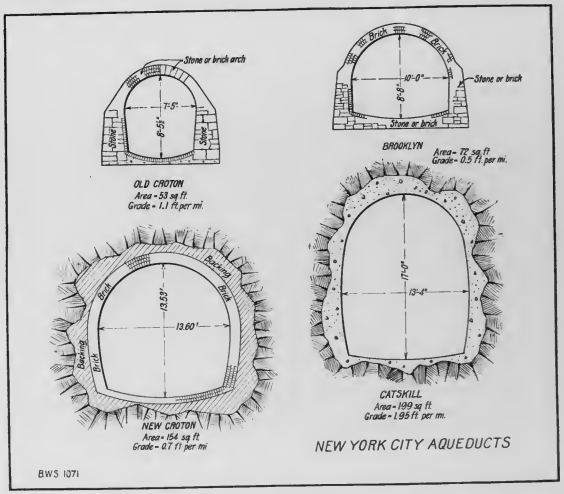


MOUNT PROSPECT LABORATORY, BROOKLYN

Mount Prospect Laboratory—The Department of Water Supply, Gas and Electricity has two well-equipped laboratories. One, located at Mount Kisco, is used for the examination of the water-supplies of the Croton, Bronx and Byram watersheds. The main laboratory, at Mount Prospect reservoir, Brooklyn, is equipped to analyze and test all materials and supplies purchased by the Department, as well as to examine the water-supplies for all boroughs. This laboratory was established in 1897 and the work has grown so that now some 6,000 analyses of water and 2,000 analyses of miscellaneous materials and supplies are made each year. From the more important water-supplies, daily samples are taken and examined, while from the less important, samples are taken at weekly, biweekly or monthly intervals. The laboratory is well equipped with modern apparatus and important research and experimental work is undertaken.

(*c*) *Consumption.*—The consumption per capita of this borough is 106 gallons, which is low for a large American city. This is due in part to water-waste-prevention inspection, which was very actively prosecuted in 1911, but mainly to the large tenement-house population, where the consumption, including waste, is small, due to the habits of the people. The total consumption is estimated as 273 million gallons daily. The demands of the consumers on the supply from the Croton river were, in 1915, about four per cent. below the estimated safe yield of this watershed. The amount drawn could be materially reduced by water-waste-prevention work, if necessary. The approaching completion of part of the Catskill system, which, it is anticipated, will be ready for use in 1916, insures the adequacy of the supply for some years.

(*d*) *Transportation and Distribution.*—To regulate the supply within the City limits, distribution reservoirs are located at Jerome park and at Central park. The Jerome Park reservoir, with a capacity of 773 million gallons, is in the Borough of The Bronx, and was first used in 1906. The Central Park reservoirs are two in number, the old reservoir first used in 1842, consisting of two basins and having a capacity of 229 million gallons; the new reservoir, built in 1862 and having a capacity of 1,016 million gallons.



Old Croton Aqueduct—The water-supply collected in the Croton valley has to be conveyed a distance of over 30 miles to deliver it into Manhattan. Over 70 years ago when the original Croton aqueduct was built it was considered that the delivery of 90 to 100 million gallons daily would be ample for the needs of The City of New York and the Old aqueduct was constructed for this capacity. This aqueduct in general was built on the side of the hills sloping down to the Hudson river, the line selected permitting the construction to be mainly in trench, only a small part of its length being in tunnel. While repairs have been made from time to time and some short sections built on embankments have been reconstructed, the Old aqueduct is still in a generally good condition and capable of delivering nearly the full capacity for which it was originally designed.

New Croton Aqueduct—When The City, about 30 years ago, decided to build a new aqueduct, a straight line was selected which carried the aqueduct mainly in tunnel. The New aqueduct has an area three times that of the Old aqueduct and a correspondingly increased capacity which is at present estimated in round figures at 300 million gallons daily. The New aqueduct is in continuous use and delivers the major part of the supply. These two aqueducts now daily deliver into the City a supply that would fill a 2-track subway tunnel 20 miles in length or from the Battery to Yonkers.

The water from the Croton lake is delivered to Manhattan through the Old and New aqueducts, and the Jerome Park reservoir, with a flow line at Elevation 134.17

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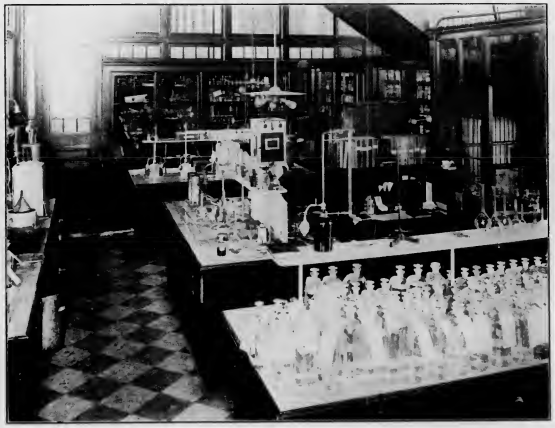

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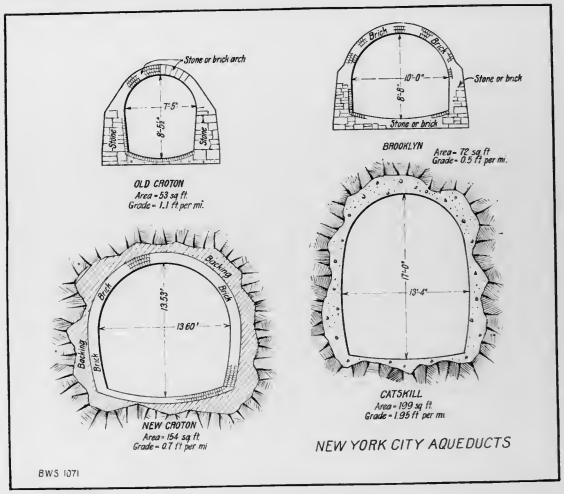

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feet, forms an equalizing basin on the aqueduct line within the City limits. All of the water brought down by these aqueducts is sent to Manhattan except about 50 million gallons which go daily to The Bronx. The Old aqueduct crosses the Harlem river at and by means of High bridge, while the New aqueduct passes underneath the Harlem river near 180th street at a depth of 300 feet below the river surface.

Croton water is delivered to Manhattan island as well as to the southerly portion

HIGH BRIDGE AQUEDUCT CROSSING OVER HARLEM RIVER

HIGH BRIDGE AQUEDUCT CROSSING—The flow of the Old Croton aqueduct is carried across the Harlem river on an imposing structure known as High bridge which is located about opposite 174th street, Manhattan. Pipes are placed in the upper part of the structure to carry the flow of the aqueduct. The cost of this bridge was about $1,000,000. A few hundred feet to the north of this bridge, the waters of the New Croton aqueduct flow through a tunnel constructed about 300 feet below the surface of the river. The tunnel construction is the modern, economical type. At the west end of the bridge is seen the High Bridge tower with the High Bridge reservoir at its base. The reservoir was put into service in 1870 and the tank in the tower in 1872. The reservoir, the water surface of which is 218 feet above sea-level, is used as an equalizing basin for the intermediate distribution service, the water for which is obtained from the Croton low service pumped at 179th Street and 98th Street stations. The tower is used as an equalizing pipe for the high service, the water being pumped at 179th Street station, the tower overflow being at an elevation of 330 feet.

of The Bronx by gravity, and after it reaches Manhattan island more than two-thirds of it is distributed to consumers by gravity. All of the waters reaching Manhattan through the two Croton aqueducts are carried to the gate-house at 135th street and Amsterdam avenue, except that some 42 million gallons a day are taken from the New Croton aqueduct at the pumping-station at 179th street and Harlem river. The gate-house at 135th street thus becomes a most important distributing center. Croton water

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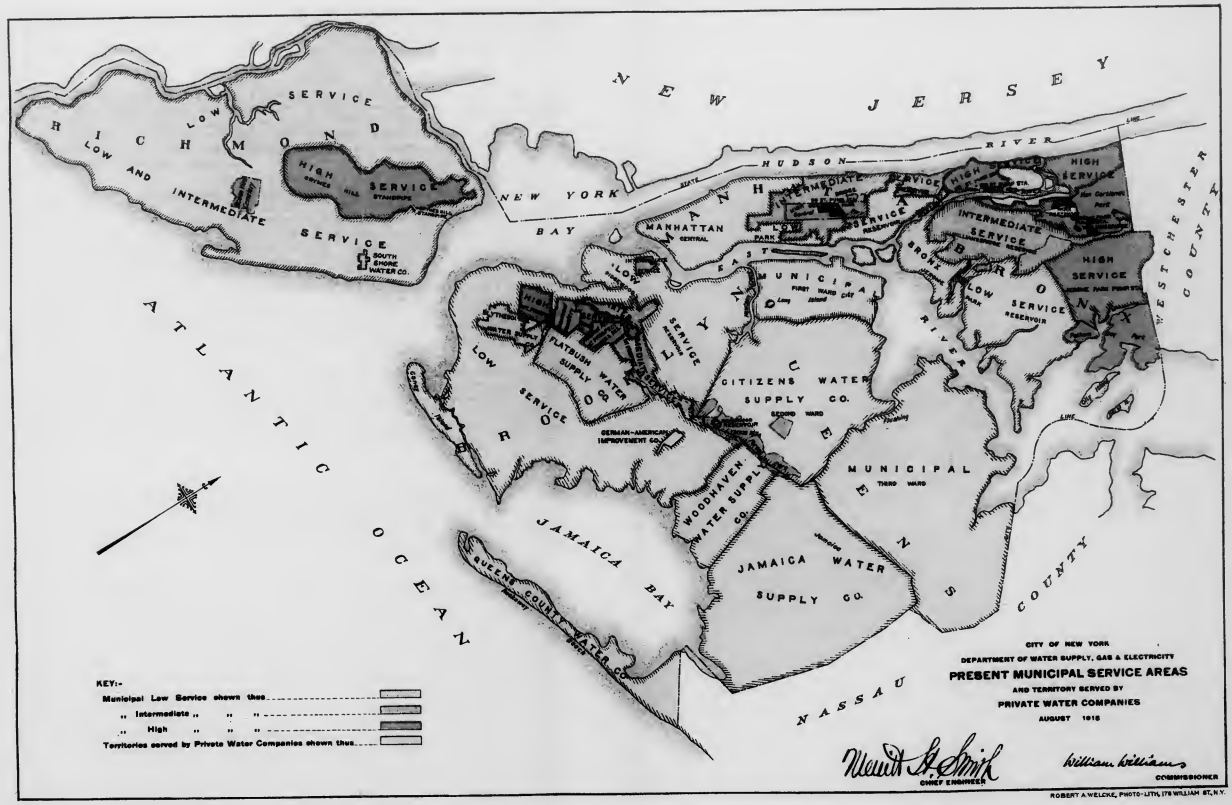
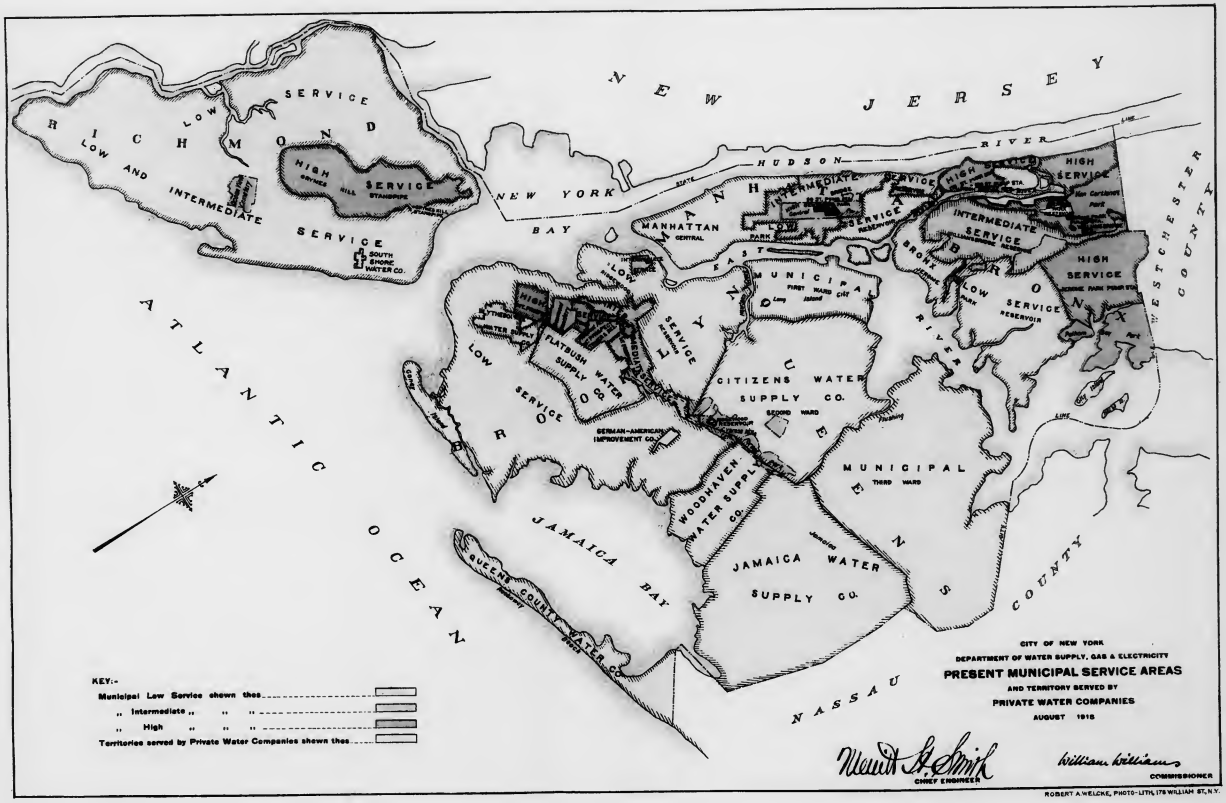


ROBERT A. WELCKE, PHOTO-LITH, 178 WILLIAM ST., N.Y.



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reaches it at an elevation of about 124 feet. All of it is sent thence by gravity into the distributing system either directly or through the distributing reservoirs in Central park, except that about 30 million gallons are sent daily to the pumping-station at 98th street and Columbus avenue. The Central Park reservoirs have an elevation of 119 feet.

The area served by gravity is known as the low-service area. It receives about 151 million gallons a day from the Central Park reservoirs and about 50 million gallons direct from the 135th street gate-house. Most buildings on ground not exceeding 50 feet above the sea-level lie within this area, which includes all of southern Manhattan. Where such buildings have more than four stories they require as a rule an independent pumping plant.

Since much of Manhattan lies higher than the maximum points which can be reached or served through pressures afforded by the Croton gravity system, it follows that a certain portion of the Croton water must be pumped, and this leads to a consideration of the intermediate service. All of the water of this service is pumped at the two large stations, one at 98th street and Columbus avenue and the other at 179th street and Harlem river. The former pumps the water into a tower stand-pipe there located with overflow at an elevation of 228 feet and the latter into the reservoir at High bridge with overflow at an elevation of 218 feet. Generally, this service is adequate for buildings on ground not higher than 100 feet and is usually limited to buildings on ground not lower than 50 feet. It occasionally serves also buildings on low ground immediately adjacent to high ground where it is more economical to use pumped water than to lay low-service mains for the supply of gravity water.

The high service is supplied with water pumped at the 179th Street station into the High Bridge stand-pipe, which overflows at 336 feet and serves the highest territory on Manhattan with a maximum elevation of 250 feet. The high-service supply reaches about 7 million gallons a day. There is inserted in this pamphlet a map which will enable the reader at a glance to see the location of the areas covered by the three Manhattan services just described as well as the different services in the other boroughs.

(*e*) *High-Pressure Fire Service.*—The regular distribution system is also used to deliver the water for fire-extinguishing purposes, but in order to better protect the lower business and manufacturing centers of Manhattan, an additional system known as the high-pressure fire-service system has been in use since 1908. The area protected by this system extends from the Battery to 34th street on the west side of Madison and Fourth avenues, and to Houston street on the east side, and contains 3,712 acres.

Two pumping-stations, one near the Hudson river at Gansevoort street, and one near the East river at Oliver street, deliver water at any pressure required by the Fire Department up to 300 pounds per square inch, obtaining the supply normally from the Croton mains, but having emergency connections so that the salt water from the rivers may be utilized. Salt water is not used because of the objectionable features of corroding the pipes and also damaging merchandise with which it comes in contact, while the Croton water does not, and as the demands of the Fire Department for a whole year are less than a day's consumption, it is considered better and more economical to use the fresh water. Each of these stations has six centrifugal pumps capable of furnishing 3,000 gallons per minute at the maximum pressure of 300 pounds and over 5,000 gallons per minute at pressure below 150 pounds. Each pump is driven by an 800-horse-power, 6,600-volt, 3-phase motor. The volume of water from one of these stations at maximum operation is equivalent to over 50 fire-engine streams. The initial pressure furnished in Manhattan is 125 pounds per square inch. When an alarm is received a pump is immediately started, and in less than a minute pressure is furnished throughout the system, even at points three or four miles away. The Fire Department uses this service for all fires within this territory and within a margin of two blocks outside of the hydrant limits. During the last two years the average number of demands on these stations, per month, based on alarms, has been 164.

To withstand this additional pressure a separate distribution system of specially-designed extra-heavy cast-iron mains, valves and hydrants had to be laid. This system is not only laid with reference to adequate service within the high-pressure territory but also has the lower east side portion so constructed that there are two separate lines of mains interconnected by means of motor-operated gate-valves, controlled from the pumping-station, the mains connected to one line being laid in alternate streets with the mains of the other line laid in the intervening streets. In case a break should occur it would affect only one of these lines, as the other would be immediately shut off from it by means of these motor-operated valves.

EXTERIOR OF SOUTH STREET HIGH-PRESSURE FIRE-SERVICE STATION

Other precautions are taken to insure efficient service: The Edison Company, which supplies the current for the pumps, has four high-tension feeders to each pumping-station, two connecting directly with the power-houses and two with its sub-stations. These feeders are for the exclusive use of the stations, and, according to the contract, are to be held in readiness for immediate use under penalty of $500 for each minute's delay after three consecutive minutes. Telephones are placed at about every two blocks for the use of the Fire Department in transmitting orders to the pumping-stations. Here also are two separate and exclusive lines interconnected with both stations. There is also a number of men detailed to visit all two or three-alarm fires in the high-pressure district, in order to assist the Fire Department by taking care of emergencies, noting the pressures, and if necessary operating the valves.

(*f*) *Breaks and Repairs.*—To cope with the situations which arise when breaks in the mains occur, repair companies are maintained in each borough. There are 18 of these companies, composed in all of about 600 men. They are distributed as follows:

6 in Manhattan borough, 3 in The Bronx, 4 in Brooklyn, 2 in Queens and 3 in Richmond. While during the course of a year several thousand leaks occur in the water-mains, calling for repairs, yet the number of important breaks is relatively small. While some are not readily detected, others manifest themselves at once and in a manner most distressing to the residents of the neighborhood where they occur. The havoc that can be created through the breaking of one of the large water-mains must be seen to be appreciated. Cast-iron pipes in the ground may have a long life, but this is upon condition that they be properly laid and allowed to remain undisturbed. In many streets of New York, however, they do not remain undisturbed, one of the reasons being that new subsurface structures are being frequently introduced and old

INTERIOR OF SOUTH STREET HIGH-PRESSURE FIRE-SERVICE STATION

ones altered, and thus the fill supporting the mains may settle, whereupon a break is likely to occur.

In the past horses and wagons have been used as the main source of transportation for the repair companies in all boroughs. Due to the fact that delay in reaching broken mains may mean serious property damage and even loss of life, it was decided to equip the companies with automobiles, and they are now partially so equipped. It is expected that with complete motorization the transportation facilities of our repair companies can be favorably compared with those of the gas, electric-light and railroad companies throughout the City. Thereafter it will be possible when a water-main breaks, for the men (who may be performing odd repair jobs throughout the district in which they are assigned) to be quickly assembled at the point where the accident has occurred.

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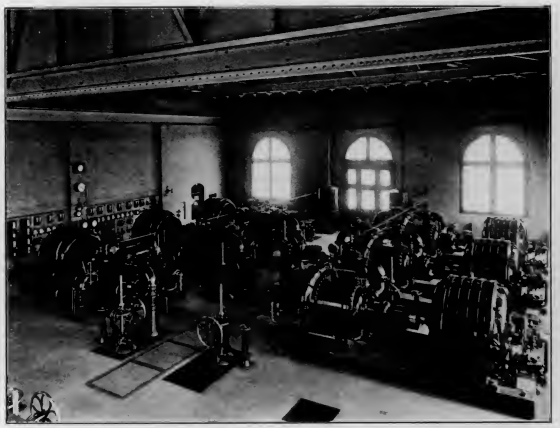

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2. BOROUGH OF THE BRONX

The Borough of The Bronx is really an extension of the Borough of Manhattan. It is supplied from two sources; nearly three-quarters of the supply comes from the Croton system and the remainder from the Bronx and Byram systems. The Bronx river was first developed in 1884 to relieve the shortage of water from the Croton system, and the Byram river was added in 1897. The combined watersheds of these two rivers cover 22 square miles and lie adjacent to and south of the Croton watershed. The waters from these two sheds were formerly delivered into a pipe-line 48 inches in diameter and 15.2 miles long, leading from what was known as Kensico lake. The construction of the new Kensico reservoir by the Board of Water Supply necessitated the removal of the dam forming Kensico lake and the supply is now delivered from the new Kensico reservoir, the temporary reservoir being included in and submerged by the waters of the same. The water, about 18 million gallons daily, is delivered through the 48-inch pipe-line into the Williamsbridge reservoir at an elevation of 193 feet, this reservoir being the equalizing basin for the intermediate service in The Bronx. The low service in The Bronx is supplied entirely by Croton water delivered by gravity. The supply for the intermediate service is supplemented by pumping Croton water at the Jerome Park pumping-station, and at the same station is pumped the supply for the high service, the water being raised into a stand-pipe to an overflow elevation of 303 feet.

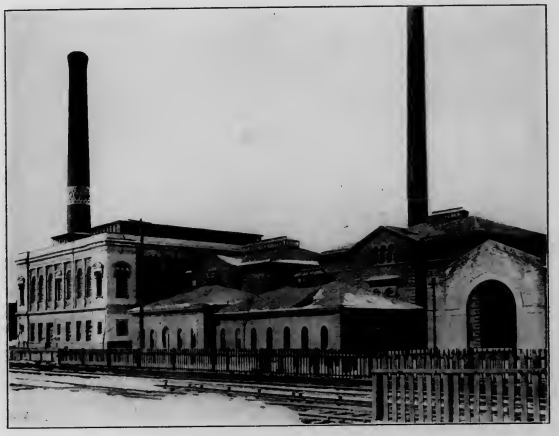
The estimated consumption for 1915 was 68 million gallons daily, equivalent to 123 gallons per capita.

3. BOROUGH OF BROOKLYN

The former City of Brooklyn, like the former City of New York, did not develop a public water-supply system until its population had reached nearly 300,000, the use of wells and cisterns being the only sources of supply prior to 1859, when water collected on the south side of Long Island was first delivered into a distribution system. Within ten years the original works, which extended easterly to the Hempstead valley, were found to be inadequate, and from that time on additions were made as necessity demanded. The principal addition was the extension of the work easterly to Massapequa, Long Island, between 1889 and 1892, at which time the Millburn and the Ridgewood South Side pumping-stations were constructed.

The Borough of Brooklyn is supplied from the watershed formed by the south side of Long Island, the works extending easterly 23 miles beyond the limits of the borough to the Suffolk County line and containing 168 square miles. The south side of Long Island is the out-wash from a terminal moraine and is composed of layers of sand, gravel and clay. Due to the porous character of the soil practically all the rainfall is absorbed and passes underground towards the sea. A small portion appears in the form of streams where the surface of the ground dips below the water-table. Small earthen dams on the various streams form 11 supply ponds. There are no large storage reservoirs on the watershed. Driven wells of a depth from about 30 feet to several hundred feet are utilized for a large part of the supply, and furnished in 1915 an average of 62 million gallons daily. Infiltration galleries, laid for nearly six miles, about 10 to 15 feet below the water-table, yield between 30 and 40 million gallons daily. Both surface and subsurface water is collected at varying intervals along the southern portion of the watershed, which is in general a mile from tide-water. Somewhat less than one-half the supply is elevated by an intermediate pumping-station located near Freeport, Long Island, and thence delivered by gravity to the Ridgewood station, located a mile west of the borough line. At this station the water for the low and intermediate services is pumped. The low-service water is delivered at the Ridgewood Reservoir level of 172 feet and the intermediate service water to the Mount Prospect Reservoir level at an elevation of 200 feet. About 10 per cent. of the supply is repumped at the Mount Prospect station, located near Prospect park, to the Mount Prospect Tower level, with an overflow of 280 feet, this tower controlling the high-service level. Three driven-well stations, located within the borough limits, pump their supply directly into the low-service distribution mains.

The Brooklyn system, as developed, is estimated to have a safe capacity of 150 million gallons daily, which is sufficient to meet all anticipated demands prior to the introduction of the Catskill water. The consumption in 1915 for municipal supply was 128.8 million gallons daily, equivalent to a daily per capita consumption of about 76 gallons. This low consumption is attributable to house-to-house inspection to prevent waste, which has been prosecuted actively from June, 1912, to June, 1913, and from June, 1914, to date.



RIDGEWOOD PUMPING-STATION

RIDGEWOOD PUMPING-STATION—The water-supply for Brooklyn is collected on Long Island very near the sea-level. All of it must be pumped once and some of the water is pumped four times before it reaches the consumer. Pumping-plants are therefore an important part of this system.

The most important station is the Ridgewood pumping-station which is located near the eastern boundary of the borough on the line of the Long Island railroad. This railroad divides the station into two parts. The North Side station, illustrated above, includes the original station put into operation in 1859. This North Side station has had additions made to it from time to time, the latest and most important being completed in 1913. The North Side station pumped during 1915, 84 million gallons daily and the South Side station 39 million gallons daily. The two stations consume about 150 tons of coal daily and have a total pump and boiler equipment as follows:

	NORTH SIDE STATION	SOUTH SIDE STATION
Rated pump capacity	163 million gallons	60 million gallons
Boiler, horse-power	4,800	1,625

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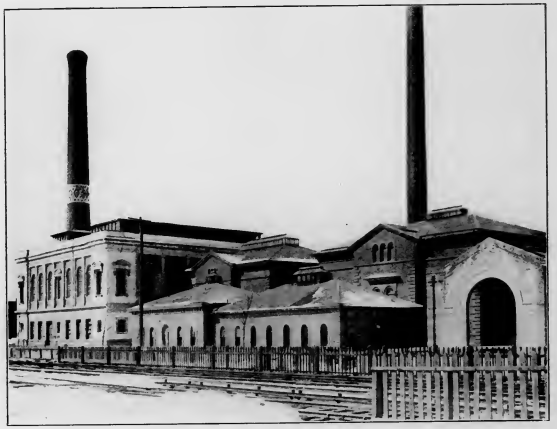

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In Brooklyn the main high-pressure fire-service system protects the important manufacturing business and water-front section lying between 39th street and the

MILLBURN PUMPING-STATION

MILLBURN PUMPING-STATION—The water obtained from more than half of the Brooklyn watershed is delivered to an intermediate station located near Freeport and known as the Millburn pumping-station. It is here pumped to a sufficient level to deliver it to the Ridgewood station. From 45 to 75 million gallons are daily pumped against a head of a little over 40 feet and 20 tons of coal are used daily. The equipment consists of seven horizontal direct-acting pumps having a total capacity of 70 million gallons daily.

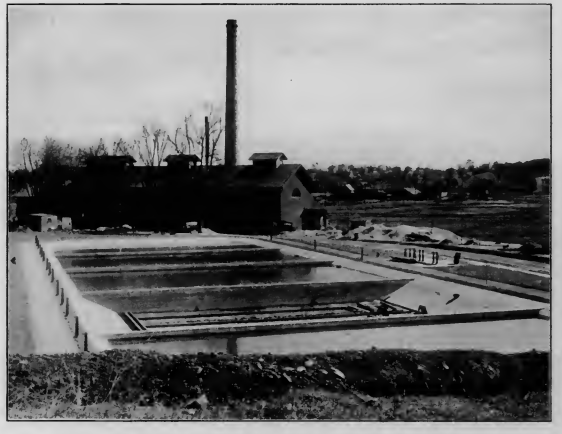
Navy Yard. This system is similar to that in the Borough of Manhattan, and is served by two stations, their capacity being two-thirds of that of the Manhattan stations. A small high-pressure system was installed in 1904 to protect the amusement section of Coney Island. There is one station equipped with gas engines that drive three pumps capable of supplying 4,500 gallons per minute at a maximum pressure of 150 pounds per square inch. This output is equal to that of six fire-engines.

In addition to the municipal system there are three private water companies that serve sections of Brooklyn, the total supply from these companies being slightly over 10 per cent. of the municipal supply.

4. BOROUGH OF QUEENS

This borough is made up of several communities, some of which developed a local water-supply as far back as the 70's. No works of magnitude have been necessary for these communities.

The sources of supply for this borough are various. The First ward is supplied from the Brooklyn system, supplemented by a small amount derived from the municipal



BAYSIDE PUMPING-STATION AND FILTER-BEDS, QUEENS

QUEENS—Two pumping-stations furnish the supply for the Third ward, Queens, the Flushing pumping-station deriving its entire supply from wells, while the Bayside pumping-station, which is illustrated above, obtains its supply both from wells and surface sources. This station is located adjacent to the salt-water meadows between Bayside and Douglaston, Long Island. The average daily supply is a little over 3 million gallons, about one-half of which comes from Oakland lake which has a small tributary area and is fed mainly by springs. The water is sufficiently polluted to necessitate filtration and five filter-beds were put in operation in the fall of 1911. The beds operate at a rate of 5 million gallons per day per acre. After the water is filtered and before it is delivered to the pumps it is treated with chlorine gas.

pumping-stations in the Third ward, Queens. The Third ward is supplied by two pumping-stations, one station drawing its supply entirely from driven wells and the other obtaining approximately half its supply from a small lake, the water being filtered. The Second, Fourth and Fifth wards are supplied by private water companies, the source of supply being entirely ground-water collected by means of driven wells. There are four principal private water companies, exclusive of the one which serves the Long Island Railroad Company.

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In Brooklyn the main high-pressure fire-service system protects the important manufacturing business and water-front section lying between 39th street and the

MILLBURN PUMPING-STATION

MILLBURN PUMPING-STATION—The water obtained from more than half of the Brooklyn watershed is delivered to an intermediate station located near Freeport and known as the Millburn pumping-station. It is here pumped to a sufficient level to deliver it to the Ridgewood station. From 45 to 75 million gallons are daily pumped against a head of a little over 40 feet and 20 tons of coal are used daily. The equipment consists of seven horizontal direct-acting pumps having a total capacity of 70 million gallons daily.

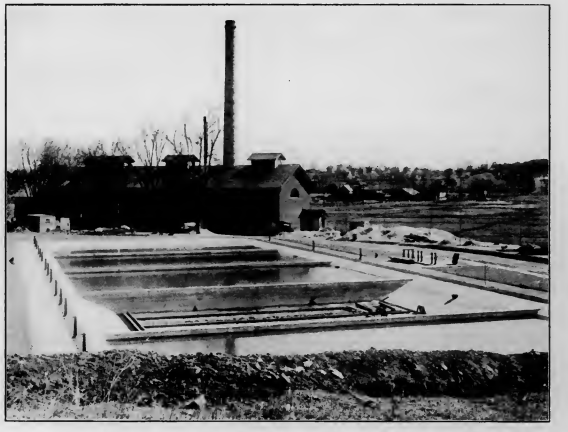
Navy Yard. This system is similar to that in the Borough of Manhattan, and is served by two stations, their capacity being two-thirds of that of the Manhattan stations. A small high-pressure system was installed in 1904 to protect the amusement section of Coney Island. There is one station equipped with gas engines that drive three pumps capable of supplying 4,500 gallons per minute at a maximum pressure of 150 pounds per square inch. This output is equal to that of six fire-engines.

In addition to the municipal system there are three private water companies that serve sections of Brooklyn, the total supply from these companies being slightly over 10 per cent. of the municipal supply.

4. BOROUGH OF QUEENS

This borough is made up of several communities, some of which developed a local water-supply as far back as the 70's. No works of magnitude have been necessary for these communities.

The sources of supply for this borough are various. The First ward is supplied from the Brooklyn system, supplemented by a small amount derived from the municipal



BAYSIDE PUMPING-STATION AND FILTER-BEDS, QUEENS

QUEENS—Two pumping-stations furnish the supply for the Third ward, Queens, the Flushing pumping-station deriving its entire supply from wells, while the Bayside pumping-station, which is illustrated above, obtains its supply both from wells and surface sources. This station is located adjacent to the salt-water meadows between Bayside and Douglaston, Long Island. The average daily supply is a little over 3 million gallons, about one-half of which comes from Oakland lake which has a small tributary area and is fed mainly by springs. The water is sufficiently polluted to necessitate filtration and five filter-beds were put in operation in the fall of 1911. The beds operate at a rate of 5 million gallons per day per acre. After the water is filtered and before it is delivered to the pumps it is treated with chlorine gas.

pumping-stations in the Third ward, Queens. The Third ward is supplied by two pumping-stations, one station drawing its supply entirely from driven wells and the other obtaining approximately half its supply from a small lake, the water being filtered. The Second, Fourth and Fifth wards are supplied by private water companies, the source of supply being entirely ground-water collected by means of driven wells. There are four principal private water companies, exclusive of the one which serves the Long Island Railroad Company.

5. BOROUGH OF RICHMOND

The City, down to 1909, owned and operated only a small plant at Tottenville, which had become a part of The City's system upon the incorporation of Greater New York. In 1909 The City acquired, by purchase, the two private companies that supplied the major portion of the borough.

GRANT CITY PUMPING-STATION, RICHMOND

RICHMOND—This borough is supplied by six pumping-stations, all but one of which were formerly owned by private water companies and purchased by The City. The supply has for many years been unsatisfactory in quality and at times deficient in quantity. It is expected that the Catskill supply will replace the local supply. To meet the immediate needs, a driven-well system has recently been constructed along the Southfield boulevard on the southeast side of the Island where the out-wash of the terminal moraine offers advantageous conditions for such a development. This development was placed in service in the spring of 1915 and has an estimated yield of about seven million gallons daily, which is over 50 per cent. of the present consumption of the borough. The development consists of five driven-well groups, located along the Southfield boulevard at intervals of about 4,000 feet. Electrically-driven centrifugal pumps deliver the water from the well systems to the pump-well at the central Grant City station, which is illustrated above, the pump for the central well group being located in this station. The electric power for the auxiliary pumps is generated at this station at 550 volts and transmitted by overhead lines to the four auxiliary stations. There are two 100-kilowatt direct-current generators to furnish this power. The water is delivered into the distribution system at a pressure of about 110 pounds per square inch, by means of three horizontal pumps having a total capacity of about 12 million gallons daily. The cost of the entire development is about $260,000.

The Borough of Richmond is dependent for its supply on ground-water drawn from wells. The City owns and operates six small plants. The largest plant (on the Southfield boulevard) was put in operation in 1915, consists of four auxiliary driven-well units and uses electrically-driven centrifugal pumps to collect the supply and deliver it to the main station, where a fifth well group is located. At the main station, steam-pumps deliver the supply directly into the distribution system.

The southwestern portion of the Island forms the Tottenville low-service area, the pressure being controlled by a stand-pipe with an overflow at an elevation of 143 feet. For the remainder of the Island the Third Avenue reservoir with an elevation of 212 feet is utilized for the low service. For the intermediate service the Clove reservoir at elevation of 254 feet controls the pressure, but the intermediate and low-service areas are interconnected due to location and capacity of existing pumping-stations. The high service is controlled by the Grymes Hill stand-pipe, with overflow at elevation of 453 feet. A private company operates a very small plant at New Dorp, supplying about 0.1 million gallons daily.

6. COMPARATIVE COSTS OF SUPPLIES

The Catskill supply, like the Croton supply, will be essentially a gravity supply and the cost of delivering the same consequently low. The differences between the cost of delivering a gravity supply on the one hand and a pumped supply on the other hand are very striking as shown by the following table, in which the figures in Column A represent merely the outlay per million gallons required to utilize the supply. Column B shows the total cost per million gallons based on the fixed charges and annual cost of operation and maintenance.

	A	B
Catskill, Bronx and Byram gravity supplies	$0.50	*$82.00
Croton gravity supply	0.65 }	37.50
Croton pumped supply	5.50 }	
Brooklyn pumped supply	17.20	60.70
Queens pumped supply	23.50	89.60
Richmond pumped supply	24.00	115.10

*Does not include fixed charges and cost of operation and maintenance of distribution system, so that for comparison with costs of supply from other sources a figure of $20 per million gallons should be added

The reader is reminded that the foregoing figures in Column A take no note of the heavier capital expenditures necessary to create a gravity supply as compared with those required to create a pumped supply. The main reason why the cost of pumping Croton water is far lower than that of pumping water in the other boroughs, is that Croton water goes to the pumps in Manhattan and The Bronx by gravity at a hight of over 120 feet above the tide level, whereas elsewhere the water has first to be lifted from the ground-water level, which is practically tide level, before it can be pumped.

7. THE PRIVATE WATER COMPANIES

They are located in the Boroughs of Brooklyn, Queens and Richmond and supply water to about 400,000 inhabitants at varying rates. Only one has an exclusive franchise. Under the Charter the Commissioner "may exercise superintendence, regulation and control in respect to the supply of water by such water companies including rates, fares and charges to be made therefor." The Commissioner's findings are subject to court revision. He has during the past two years exercised his regulatory powers in several instances and his decisions have been accepted as just and reasonable. It is the Department's opinion that The City's municipal water service ought to be extended ultimately to all sections of Greater New York so that it may supply water all over The City at uniform rates. How this shall be accomplished is a matter for future determination.

8. COLLECTION OF WATER REVENUE; WATER-METERS

The work hereunder is performed through the Bureau of Water Register. Charges for municipal water are based either upon frontage rates or meter rates. The annual frontage rate varies from $4 for a one-story building 16 feet wide to $14 for a one-story building 50 feet wide. To these rates $2 is added for each 10 feet in excess of a 50-foot frontage, and $1 for each story above the first. When more than one family occupy the same building, $1 is charged for each additional family. There are other miscellaneous charges.

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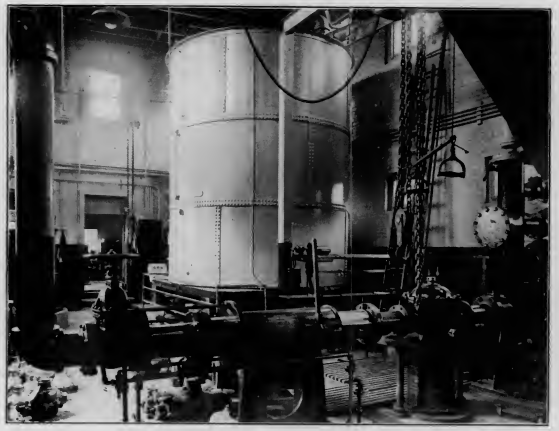
The Commissioner may direct the installation of meters in all business premises and he has done so. Virtually all business premises are now and for some time past have been metered. The charge for metered water is 10 cents per hundred cubic feet. Approximately one-half of the revenues is derived through meter accounts and one-half through frontage accounts. Though an estimate shows only about 26 per cent. of the water consumed to be metered, yet the revenue from metered water exceeds somewhat that derived from unmetered water. The Department is advocating the installation of meters on all premises using water.



METER-TESTING SHOP, EAST 24TH STREET, MANHATTAN

METER TESTING—The City does not own or install meters, but it does test, free of charge, all meters that are installed, both new meters and those that have been removed for repairs. At the shop illustrated above, are tested all the meters for the Boroughs of Manhattan, The Bronx, Queens and Richmond, there being about 2,000 meters tested monthly. The shop is equipped with two testing-machines for small-size meters, one machine for ½-inch to 2-inch meters and one large machine for meters from 1½ inches to 8 inches. There is also apparatus for testing hot-water meters. The water used in the tests can be measured both volumetrically and by weight. The capacity of the largest testing-machine is 2,000 gallons per minute, while the largest weighing tank has a capacity of 75,000 pounds.

The collection of the revenue and the work incidental thereto requires complicated machinery on which at the beginning of 1916 about 438 men were employed. This work includes the inspection of buildings for water charges (e. g., examination of fixtures, reading of meters, inspection of meters and seals and examination of work performed by licensed plumbers), the supervision of water used in the harbor of New York, at the wharves by shipping interests, the use of water by contractors and builders, the use of hose and efforts to prevent waste of water through leaks and otherwise.

9. REVENUE AND COST OF OPERATION

The total appraised value of the existing water-supply system of Greater New York as of December 31, 1915, is $226,700,000, which is $135,000,000 in excess of the amount of bonds outstanding for the construction thereof. The total amount of bonds issued for the construction of the works is $200,800,000, or about $26,000,000 less than the appraised value of the works, this difference being principally due to the increase in the value of the landed property, which is appraised at $86,000,000.

The total income from the sale of water amounts to approximately $13,000,000 and the total operating expenses to about $4,000,000 per annum. After deducting the cost of operation and the interest and sinking fund charges on outstanding bonds, the latter amounting to $5,000,000, there is a net balance of about $4,000,000. The revenues from the sale of water in the various boroughs, with the exception of the Borough of Brooklyn, are credited to the fund for the reduction of the general debt. In the Borough of Brooklyn the revenues are used to pay the maintenance and operating expenses of the Water Department, and interest and sinking fund charges on outstanding bonds for the water-supply system in that borough, and the surplus, if any, goes into the general fund for the reduction of The City debt.

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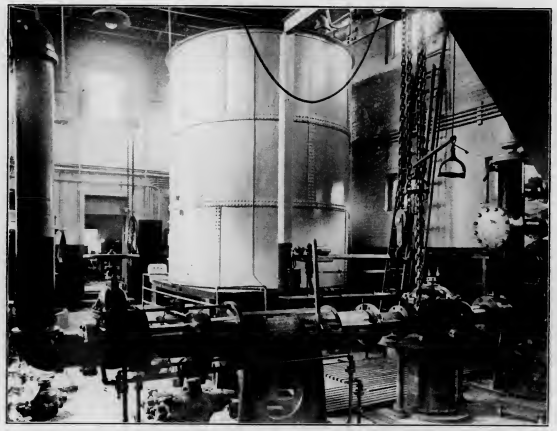

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STATISTICS

(a) BOROUGHS OF MANHATTAN AND THE BRONX

Sources of Supply

(1) Croton river, first used in 1842; (2) Bronx river, first used in 1884; (3) Byram river, first used in 1897.

Areas of Watersheds

(1) Croton, 375 square miles; (2) Bronx, 14 square miles; (3) Byram, 8 square miles.

Rainfall and Run-off

The total rainfall for Manhattan and The Bronx was 51.76 inches during 1915. The run-off was 26.02. The average rainfall for the past 48 years is 48.68 inches.

Storage Reservoirs on Croton, Bronx and Byram Watersheds

Name	Year First Used	*Elevation of Spillway, Feet	Water Surface, Square Miles	Storage with Flash Boards, Million Gallons	Tributary Watershed, Square Miles
CROTON WATERSHED					
Boyds Corners	1873	600	0.436	2,727	22
Middle Branch	1878	380	0.672	4,155	21
Sodom	1891	417	0.898	5,243	80
Bog Brook	1891	417	0.640	4,400	4
West Branch	1895	503	1.560	10,669	43
Amawalk	1897	400	0.940	7,086	19
Croton Falls	1911	310	1.910	14,865	169
Croton Falls Diverting Dam	1911	310		888	88
Titicus	1893	325	1.103	7,617	21
Cross River	1908	330	1.310	10,923	30
Croton Lake	1905	200	5.574	28,110	375
Croton above Muscoot	1905	200		5,705	316
Lake Mahopac	1870	660	0.875	575	2
Lake Kirk	1870	583	0.158	565	3
Lake Gleneida	1870	505	0.284	165	1
Lake Gilead	1870	497	0.190	380	1
Barrets Pond	1870	779	0.108	170	1
White Pond	1899	831	0.176	200	1
Totals	....	....	16.834	104,443	...
BRONX AND BYRAM WATERSHEDS					
Rye Dike	1884	318	0.500	5,145	...
Byram	1897	452	0.250	925	...
Bronx Dike	1884	320	0.105	128	...
Wampus	1897	410	0.072	86	...
Totals	....	....	0.927	6,284	22

* Elevations refer to Croton datum = 0.94 foot below datum of mean sea-level at Sandy Hook

Aqueducts

There are two aqueducts known as the "Old" and "New" Croton, respectively.

The Old Croton aqueduct is 34 miles long, about 7½ feet wide and 8 feet high, giving a cross-sectional area of about 53 square feet. It has a slope of 1.1 feet per mile and has a maximum capacity of 90 million gallons daily.

The New Croton aqueduct is 31 miles long, of horseshoe shape, 13.6 feet wide and 13.5 feet high, giving a cross-sectional area of 154 square feet. The slope is 0.7 foot per mile and the aqueduct has a maximum capacity of 300 million gallons daily.

A 48-inch pipe, 15.2 miles in length, delivers the supply from the Bronx and Byram watersheds to Williamsbridge reservoir. It has a capacity of 18 million gallons daily.

The total daily capacity of the aqueducts supplying Manhattan and The Bronx is 408 million gallons.

Pumping-Stations

There are four stations with an aggregate pump capacity of 155 million gallons daily. These pumped 108.3 million gallons daily during 1915.

Distribution Reservoirs

Name	Year First Used	Elevation of Spillway, Feet	Water Surface, Square Miles	Storage with Flash Boards, Million Gallons
Jerome Park	1906	134	0.142	773
High Bridge	1870	218	0.003	11
Williamsbridge	1889	193	0.018	147
Central Park (old)	1842	119	0.048	229
Central Park (new)	1862	119	0.150	1,016
Totals	....	....	0.361	2,176

All elevations refer to datum of mean sea-level at Sandy Hook

Distribution Services

Supply	Estimated Consumption, 1915, Million Gallons Daily
Manhattan	
Low-service gravity (water in Central Park reservoir, Elevation 119 feet)	201
Intermediate service (High Bridge reservoir, Elevation 218 feet)	65
High service (High Bridge stand-pipe, Elevation 336 feet)	7
Bronx	
Low-service gravity (Jerome Park reservoir, Elevation 134 feet)	23
Intermediate service (Williamsbridge reservoir, Elevation 193 feet)	34
High service (Jerome Avenue pumping-station, stand-pipe, Elevation 303 feet)	11
Total	341

All elevations refer to datum of mean sea-level at Sandy Hook

Distribution System (December 31, 1915)

Consists of about 1,338 miles of mains varying from 4 to 66 inches in diameter on which there have been set 30,507 gates and 20,580 hydrants. There are in place 182,878 taps and 60,728 meters. The percentage of taps metered is 33.2.

Consumption

During the year 1915 the average daily consumption for Manhattan and The Bronx was 341 million gallons for a population of about 3,138,000, which corresponds to a daily consumption per capita of 109 gallons.

(b) BOROUGH OF BROOKLYN

Source of Supply

Driven wells, infiltration galleries, and small streams along the south shore of Long Island; this system was first introduced in 1859.

Area of Watershed

Ridgewood watershed has an area of 168 square miles.

Rainfall

The total rainfall for Brooklyn was 46.53 inches during the year 1915. The average rainfall for last 54 years is 43.28.

Storage Reservoirs

There is only one reservoir which contains over 50 million gallons. It is known as the Hempstead storage reservoir and has a capacity of about 1,000 million gallons.

Transportation System—Brooklyn

Description of Conduit	East Limit	West Limit	Length Miles	Minimum Section	Maximum Section	*Estimated Capacity of Maximum Section, Million Gallons Daily
Masonry conduit	Massapequa Pond	Millburn Sta.	7.3	7′4″x5′11″	9′4″x6′11″	59
Steel pipe	Suffolk Co. Line	Pitkin Ave., Brooklyn	23.4	.....	72″	57
Two cast-iron pipes	Millburn Sta.	Ridgewood Sta.	15.0	.....	48″	50
One cast-iron pipe	Millburn Sta.	Millburn Res. Efflux	1.6	.....	48″	25
One cast-iron pipe	Millburn Res. Efflux	Smith's Pond	1.4	.....	36″	14
Masonry conduit	Hempstead Pond	Ridgewood Sta.	12.4	8′2″x6′4″	10′0″x8′8″	76
One cast-iron pipe	Spring Creek	Ridgewood Sta.	0.9	.....	48″	25
One cast-iron pipe	Pitkin Ave., Brooklyn	Ridgewood Sta.	0.7	.....	48″	25

*Capacity of pipes estimated on basis of velocity of 3 feet per second

Pumping-Stations

There are 31 stations with an aggregate pump capacity of 590 million gallons daily. Thirty of these stations were operated during 1915 and pumped 312 million gallons daily. The supply is all pumped once and portions thereof two, three or four times.

Distribution Reservoirs

Reservoir	Capacity, Million Gallons
Ridgewood (3 basins), Elevation 172 feet	304
Mount Prospect, Elevation 200 feet	19
Mount Prospect tower, Elevation 280 feet	0.1
Total	323.1

All elevations refer to datum of mean sea-level at Sandy Hook

Distribution Services

Supply	Estimated Consumption, 1915, Million Gallons Daily
PUBLIC SYSTEMS	
Ridgewood or low service (Ridgewood reservoir, Elevation 172 feet)	100.5
Mount Prospect reservoir or intermediate service, Elevation 200 feet	18.0
Mount Prospect tower or high service, stand-pipe, Elevation 280 feet	10.3
Total	128.8
PRIVATE COMPANIES	
Flatbush Water Works Co. supplies 29th ward (stand-pipe, Elevation 182 feet)	11.5
Blythebourne Water Works Co. supplies part of 30th ward (four tanks, Elevation 142 feet)	2.0
German-American Improvement Co. supplies small part of 26th ward (stand-pipe)	0.6
Total	14.1

All elevations refer to datum of mean sea-level at Sandy Hook

Distribution System (December 31, 1915)

There are 1,080 miles of mains, varying between 4 and 66 inches, with 24,222 gates and 18,240 hydrants in the municipal system. There are in place 169,928 taps and 27,271 meters. The percentage of taps metered is 16.

Consumption

The average daily consumption for the year 1915 was 142.9 million gallons daily from both the public and private systems, for an estimated population of 1,881,000, which corresponds to a per capita consumption of 76 gallons daily.

(c) BOROUGH OF QUEENS

Source of Supply

Driven wells (public and private systems).
Also small lake in public system from which about 1.5 million gallons daily are obtained, the same being afterwards filtered.

Pumping-Stations

There are two municipal pumping-stations which are practically in continuous operation during the year, these operating in the Third ward. An additional station is held as a reserve.

Distribution Services

Supply		Estimated Consumption, 1915, Million Gallons Daily
*First ward (Long Island City):		
From Brooklyn source	6.9	
From Third ward (Flushing and Bayside pumping-stations)	1.6	8.8
From Whitestone and No. 1 pumping-station	0.3	
By purchase from Citizens' Water Supply Co. (Private)	0.01	
Second ward, Citizens' Water Supply Co. (Private)		6.5
Urban Water Supply Co. (Private)		1.3
*Third ward, Flushing and Bayside pumping-stations		4.2
Fourth ward:		
Jamaica Water Supply Co. (Private)	6.9	9.2
Woodhaven Water Supply Co. (Private)	2.3	
Fifth ward, Queens County Water Co. (Private)		2.4
Total		32.4

* In the First Ward service, average elevation 148 feet, no distribution reservoirs or stand-pipes are used, while in the Third Ward service, average elevation 175 feet, two stand-pipes with overflow elevation at Flushing of 221 feet and at College Point of 192 feet, are used. All elevations refer to datum of mean sea-level at Sandy Hook

Distribution System, Municipal (December 31, 1915)

Consists of 237 miles of mains, varying in diameter from 4 to 30 inches, on which have been set 4,240 gates and 2,843 hydrants. There are in place 11,431 taps and 7,881 meters. The percentage of taps metered is 68.8.

Consumption

During the year 1915 the consumption from both public and private systems was 32.4 million gallons daily, for a population of about 353,000, corresponding to a per capita consumption of about 96 gallons daily.

(d) BOROUGH OF RICHMOND

Source of Supply

Driven wells.

Pumping-Stations

There are six permanent and two temporary stations, with an aggregate pump capacity of 30 million gallons daily. These pumped 12.9 million gallons daily during 1915.

Distribution Services

Supply	Estimated Consumption, 1915, Million Gallons Daily
Southern and western portions, Tottenville pumping-station (stand-pipe, Elevation 143 feet)	0.2
Highest levels of eastern and southern portions, Clove high service (limiting elevation 453 feet) Grymes Hill stand-pipe	1.2
The remainder without any district divisions; Reservoir elevations: Clove, 254 feet; Third Avenue, 212 feet	10.1
New Dorp, South Shore Water Works Co. (private company)	0.1
Total	11.6

All elevations refer to datum of mean sea-level at Sandy Hook

Distribution System (December 31, 1915)

Consists of 257 miles of mains, varying in diameter from 4 to 48 inches, on which have been placed 5,201 gates and 2,764 hydrants. There are in place 15,075 taps and 5,188 meters. The percentage of taps metered is 34.4.

Consumption

The consumption during the year was 11.6 million gallons daily for an estimated population of 96,000, which corresponds to a per capita consumption of 121 gallons daily.

(e) DAILY CONSUMPTION (MILLION GALLONS) DURING 1915

	*Manhattan and The Bronx	Brooklyn	Queens	Richmond	Total
Public systems, average...	341.3	128.8	13.0	11.5	494.6
**Private systems, average.	....	14.1	19.4	0.1	33.6
Total average	341.3	142.9	32.4	11.6	528.2
Estimated population 3,138,000		1,881,000	353,000	96,000	5,468,000
Gallons per capita.....	109	76	96	121	97

*Includes 18 million gallons daily from Bronx and Byram watersheds
** Private Companies:

		Million Gallons Daily
Brooklyn....	Flatbush Water Works Co. (Supplies 29th ward).....	11.5
	Blythebourne Water Works Co. (Supplies part of 30th ward)	2.0
	German-American Improvement Co. (Supplies small part of 26th ward).....	0.6
	Total	14.1
Queens.....	Citizens' Water Supply Co. (Supplies 2nd ward).....	6.5
	Jamaica Water Supply Co. (Supplies part of 4th ward)	6.9
	Woodhaven Water Supply Co. (Supplies part of 4th ward)	2.4
	Queens County Water Co. (Supplies part of 5th ward, Rockaway, etc.)	2.3
	Urban Water Supply Co. (Supplies small part of 2nd ward)	1.3
	Total	19.4
Richmond....	South Shore Water Works Co. (Supplies New Dorp)..	0.1

(f) DAILY CONSUMPTION OF WATER DURING 1915 AS COMPARED WITH OTHER AMERICAN CITIES

City	Estimated Population	Total Average Daily Consumption, Million Gallons	Average Daily Consumption Per Capita Gallons	Percentage of Taps Metered
New York	5,468,000	528.2	97	26.5
Chicago	2,448,000	579.0	237	6.6
Philadelphia	1,700,000	300.0	175	8.0
Boston	748,900	77.6	104	50.0
Cleveland	765,000	79.9	105	99.0
St. Louis	745.000	91.0	122	7.0

(g) COMPARISON OF AVERAGE DAILY CONSUMPTION DURING THE LAST TEN YEARS—ALL BOROUGHS

Year	Manhattan and The Bronx	Brooklyn	Queens	Richmond	All Boroughs
1906.....	325.0	136.7	25.8	*8.0	495.5
1907.....	330.0	149.0	28.6	*8.0	515.6
1908.....	327.0	153.0	30.0	*8.0	518.0
1909.....	323.0	151.0	30.0	8.8	512.8
1910.....	331.0	158.2	30.3	9.0	528.5
1911.....	298.0	155.2	31.6	9.6	494.4
1912.....	303.0	157.5	34.2	10.3	505.0
1913.....	314.0	140.3	33.0	11.7	499.0
1914.....	347.0	150.2	35.7	11.8	544.7
1915.....	341.3	142.9	32.4	11.6	528.2

* Estimated

(h) COST OF SUPPLY, 1915, AND REVENUE COLLECTED IN THE SEVERAL BOROUGHS, 1914—MUNICIPAL SYSTEMS

Borough	Original Total Cost of Works December 31, 1915, Estimated	Present Bonded Indebtedness on Existing Systems December 31, 1915, Estimated	Annual Cost, Fixed Charges and Operation 1915	Average Daily Supply in 1915 Million Gallons Daily
*Manhattan and The Bronx.	$138,424,000	$55,950,000	$4,669,000	341
*Brooklyn	43,856,000	21,358,000	2,859,000	129
Queens	4,022,000	3,073,000	425,000	13
Richmond	4,214,000	4,184,000	462,000	11
Totals and averages....	$190,516,000	$84,565,000	$8,415,000	494

Borough	Total Cost of Million Gallons on Basis of Fixed Charges and Operation	Revenues, 1914		
		Meter	Frontage and Miscellaneous	Total
*Manhattan and The Bronx..	$37.51	$4,561,000	$4,091,000	$8,652,000
*Brooklyn	60.71	1,503,000	2,325,000	3,828,000
Queens	89.61	326,000	136,000	462,000
Richmond	115.13	127,000	112,000	239,000
Totals and averages....	$46.67	$6,517,000	$6,664,000	$13,181,000

*Exclusive of high-pressure fire service

(i) HIGH-PRESSURE FIRE-SERVICE SYSTEM

	Manhattan	Brooklyn	
		Main System	Coney Island
Work of installation of system commenced	1904	1905	1904
Approximate cost of system (December 31, 1915)	$6,749,000	$2,214,000	$183,000
*Area protected (December 31, 1915)	3,712 acres	3,100 acres	473 acres
Miles of mains in place (December 31, 1915)	128	39	6
Size of mains	**8 to 24 inches	**8 to 20 inches	**8 to 16 inches
Number of hydrants (December 31, 1915)	2,750	1,217	150
Number of valves (December 31, 1915)	4,747	1,707	200
Number of pumping-stations	2	2	1
Number of units	12 (6 at each station)	8 (5 at main station and 3 at reserve station)	3
Total rated capacity	36,000 gallons per minute (at 300 pounds)	24,000 gallons per minute (at 300 pounds)	4,500 gallons per minute (at 150 pounds)
Power	Electric motor power supplied by Edison Company	Electric motor power supplied by Edison Company	Gas
Cost of operation of pumping-stations during 1915	$117,465	$75,620	$15,310

* Includes a strip 600 feet wide outside of the district in which mains are laid
** 8-inch mains only used for hydrant branches

MSH. 20839

END OF
TITLE